THE MONEY HUNT

Grantsmanship: What Makes Proposals Work?

A few years ago, plant molecular biologist Sue Wessler of the University of Georgia in Athens decided not to deliver the goods. About 5 months into a renewed Department of Energy grant, she realized that a friend, Vicki Chandler of the University of Oregon, was well ahead of her on the same work: a project to describe how a particular corn regulator protein affects gene expression. "I said to myself, 'If we can't beat her, we better change directions,'" says Wessler.

So she switched to the study of a different regulator. That meant she didn't complete her promised work. Yet instead of gaining a reputation for unreliability, the next time she sent in a proposal it passed with flying colors. "It was the best review I ever got," says Wessler. "The comments said the change in direction was a smart move."

Innovation, always admired, is now one of the essential ingredients of successful proposals, says Jacqueline K. Barton of the California Institute of Technology, who chairs a National Institutes of Health (NIH) study section on metallobiochemistry. "You need a significant, great idea," she says. Things have changed since the 1960s, when the award rate at NIH was about 80%. That rate fell to 50% during the 1970s and plunged to an average of 37% during the 1980s. "Now," says Marvin Cassman, deputy director of the National Institute of General Medical Sciences, "the award rate is almost one-half that of a decade ago." As the filters through which grants have to pass become finer, applications are being recycled at a furious pace. "Ten years ago, only 5% to 10% of applications were rewrites," says Donna Dean, chief of the Biological and Physiological Sciences Review Section for research grants at NIH. Now, it's 30%. Because each revision can take a month or two of concentrated work, more researchers are spending larger proportions of their time chasing grants. Indeed, according to the National Academy of Sciences, physical sciences researchers applying to the National Science Foundation (NSF) or the National Aeronautics and Space Administration (NASA) "must now write two to four proposals per year to remain funded, up from one or two in 1989."*

How do you write a proposal that stands out amidst this heightened competition? How do you avoid getting on the rewrite treadmill? *Science* spoke to program officers at NIH, NSF, and the U. S. Department of Agriculture (USDA), as well as to more than a dozen successful grant writers, most of whom have also served on review panels. Interviewees said the best proposals have two features in common: They tackle timely scientific issues and present them forcefully. "Review panels are bowled over by enthusiasm and clear thinking," says Dean of NIH.

*A Space Physics Paradox, by the Committee on Solar-Terrestrial Research, National Academy Press, 1994.

Follow directions. As for specifics, the basic rule is: Follow the rules. A surprising number of scientists don't. NSF program officers such as Marcia Steinberg, program director in molecular biochemistry, say that almost half of the proposals they have been receiving lately in some areas are returned for rewriting because they fail to follow the foundation's latest guidelines on format and budgeting.

Michael Bailey, a Northwestern University psychologist who studies sexual orientation, knows what carelessness can do. He won easy approval for his original grant proposal at the National Institute of Mental Health during the mid-80s. But more recent proposals have fallen by the wayside because of mistakes: Once he directed a proposal to the wrong agency, and another time he failed to make revisions suggested by the study section. "If I had followed directions, I could have avoided problems," says Bailey. He is by no means unusual. NSF's Steinberg says many scientists "shoot themselves in the foot by not following guidelines, by general sloppiness and poor grantsmanship." They fail to edit, to proofread, to include references they have cited, or to give clear explanations for figures they have provided. "This sounds all very bureaucratic," says Steinberg, "but scientists should realize that their failings are irritating to their peers who are trying to review their proposals."

Many scientists would fare better if they followed some simple advice from granting agencies.

At NSF, the situation has been particularly sticky since last April, when the agency issued new rules stating that project descriptions could be only 15 pages long—in 10- to 12-point type. The latter requirement was added, says Steinberg, because there are always a few researchers who drop to a smaller font to fit everything in. Often, such proposals are returned for revision without even being read.

RICK O'QUINN/UGA NEWS BUREAU

Staying competitive. Sue Wessler switched her research topic and got a rave review on her next grant.

Getting up-to-date information is also crucial. "Grant writers should have the latest instruction booklet," says Steinberg. Project officers at NSF and elsewhere say many scientists rely on booklets used for the last proposal, an error that triggers the return of a significant fraction of proposals.

Something old, something new. Once you get the format right, there's the content to worry about. The most challenging part of developing a research proposal, say experienced grant writers, is to find a balance between something sure and something new. "You have to bracket yourself between reality and creativity," says biochemist Charles Craik of the University of California, San Francisco. Sponsoring agencies are eager to find a novel hook as a way of differentiating a grant proposal from run-of-the-mill applications. Demonstrating a grip on reality, however, is equally important. "Proposals have to balance bread-and-butter and crazy ideas," says Caltech's Barton. That means unique approaches "must be backed by enough solid experiments to show a risk is worth taking," says Stephen Howell, a plant molecular biologist at the Boyce Thompson Institute for Plant Research in Ithaca, New York.

PHIZ MEZEY

Between reality and creativity. UCSF biochemist Craik switched funding agencies as his field developed.

It is also important to set out alternative strategies in case the original idea fails. "You have to lay your cards on the table, including possible pitfalls" that would prevent execution of the project as envisaged, says Barton.

The big picture. Grant writers must show how their plans fit in with the larger goals of science, says Barton. "People often talk about experiments without describing the big picture." For example, a proposal to isolate and characterize a new gene or to describe a new molecular structure may not be enough to snare a grant, unless an explanation is offered on how these discoveries relate to larger problems, such as gene regulation or structure/function relations. Take protein crystal structures, which are now being solved by crystallographers at a rate of about one per day. The techniques and materials are expensive, so proposals have to go beyond "another new one." There's got to be "a good story behind the protein," says crystallographer Joe Kraut of the University of California, San Diego.

Many proposals founder, says Dean, because they focus more on experimental minutiae, such as types of buffers used in an experiment. "The work must be put in context," she says. "You can't have people arguing" over its relevance. An agency's larger priorities should also be kept in mind. For example, Rosemary Grady, a division director at the USDA's National Research Initiative, points out that any idea "relevant to sustainability in U.S. agriculture" immediately has something going for it.

Write and rewrite. Grant applications may be funded on their scientific merit, but that merit has to be communicated in writing. And a basic tenet that's often neglected by researchers, says Dean, is that you can't expect to produce a masterpiece at the first sitting. If you want your grant application to sing, you have to work and rework it. Wessler, for example, starts at least 4 months in advance of the due date, cloistering herself in a library carrel with her "companions," a laptop computer and references. "I need solitude to think deeply and to gain focus," she says.

Writing It Wrong

There are all kinds of ways to write a bad grant. But program officers at funding agencies say the types of problems that haunt scientists tend to be different for people at different stages of their careers.

"Younger scientists are often too ambitious," says Donna Dean, chief of the Biological and Physiological Science Review Section for research grants at the National Institutes of Health. Inexperienced at foreseeing things that can go wrong, and prone to underestimate the demands of their other obligations, assistant professors often try to squash 5 to 10 years of work into a 3-year proposal. Such proposals are usually rejected. Another common problem, says Marcia Steinberg of the National Science Foundation, is the failure to demonstrate independence, particularly from one's mentor. "Me too" science doesn't rate independent funding, she explains.

With a bit more experience under their belts, newly tenured faculty members demonstrate a different failing: They've become too cautious. They hesitate to venture into new areas, says Steinberg, instead simply embellishing earlier work. Forging collaborations and recruiting consultants to a project can help scientists out of this predicament, adds Dean.

Finally, senior researchers make yet another mistake: They think they can coast on their laurels. Applications with few details that merely say "I'm Dr. Famous. Fund me," are now turned aside, says Dean.

–A.S.M.

It's also important to keep in mind the people who will be reading the application. Dean advises scientists to write the proposal for "professional faculty, but not the five or six experts in your field. Write one step back and eliminate confusing jargon." As for those who submit amended applications, "the worst thing is to agree with all criticisms. Show the robustness of your ideas." Project officers say you should leave enough time to have your grant looked at by a colleague a bit removed from your area of expertise before you send it off. That seems obvious, but a lot of people don't do it, and this was echoed by almost every program officer and reviewer spoken to by *Science*. "It's surprising how obscurities are revealed by an outside review," says biochemist Leon Heppel of Cornell University.

Steinberg makes another point: Parsimony doesn't stop at the lab door. It also applies to your grant proposal. No program officer has complained of a proposal being too short, if work is substantiated. "Good writing won't save a bad idea, but bad writing can kill a good one, especially when funds are tight," she says.

Targeting. Even if you've put together a great proposal, it's important to market your wares to the right agency or study section. Funders' priorities change, sometimes frequently. A proposal on photosynthesis, for example, may first be accepted by the USDA, but later, when a renewal is planned, the NSF or the Department of Energy may be more interested in the idea. Or rapid advancements in a field may cause a different agency to develop an interest in the area. For example, when Craik started work on protein engineering in 1984, the NSF funded his research on development of new techniques for site-directed mutagenesis. However, now that the discipline has matured and may be used to custom-design drugs, Craik is directing many of his ideas to NIH.

"You must always keep your ear to the ground for news on subjects agencies are trying to promote," says plant biologist Howell. You do that by sending for the latest instructions and an agency's latest initiatives, calling program officers, and talking with colleagues and with members of review panels and study sections.

Program officers are your friends. Don't try to guess—speak to program officers and find out an agency's current priorities, advises Craik. "They really do care," he says, adding that he's found from his own experience that "even when you're feeling at your lowest, and your proposal has been rejected, it's a good idea to talk to the program officer." They can provide insights on reviews of your grant and what changes are needed. Steinberg of NSF says, "People are fearful of calling program officers. But it is advantageous to be actively involved" with one. Adds Grady of USDA: "Nothing is more important than investing time in a talk with a program director. They know what approaches are most appropriate" in a given research area.

The good news from all this is that while competition is fierce, it is possible—indeed, it is relatively easy—to avoid making some fatal mistakes that arise from simple ignorance or arrogance. And even if you do everything right and still don't get a grant approved, Craik has consoling advice: "If you've got a good idea, it will get funded. It is basically a good system." These days, though, "it may not happen tomorrow."

–Anne Simon Moffat